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Yamashita et al.

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(45) **Date of Patent: Nov. 8, 2016**

(54) **CONNECTOR MATEABLE WITH MATING CONNECTOR AND HAVING FIRST AND SECOND MEMBERS WHICH ARE ELECTRICALLY SEPARATED**

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(21) Appl. No.: **14/727,464**

(22) Filed: **Jun. 1, 2015**

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(30) **Foreign Application Priority Data**

Jul. 25, 2014 (JP) 2014-152134

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H01R 9/05 (2006.01)
H01R 24/40 (2011.01)

(52) **U.S. Cl.**
CPC ***H01R 24/40*** (2013.01)

(58) **Field of Classification Search**
CPC H01R 24/38; H01R 9/05; H01R 9/0506; H01R 13/6592
USPC 439/578, 579, 607.41, 607.42
See application file for complete search history.

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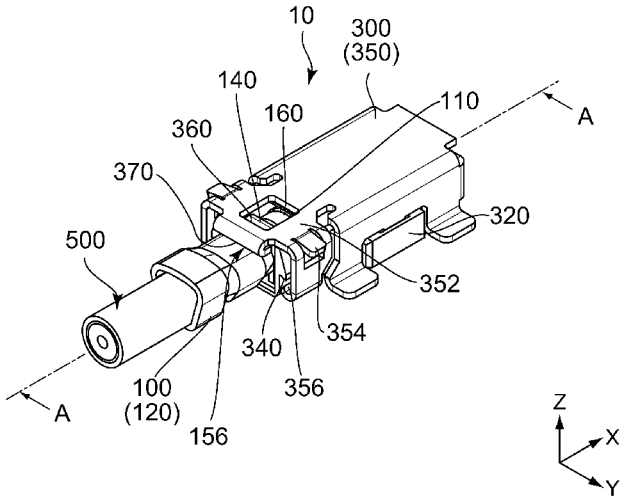
(74) *Attorney, Agent, or Firm* — Holtz, Holtz & Volek PC

(57) **ABSTRACT**

A connector is attached to a cable which has a center conductor and a shield. The connector is mateable with a mating connector along a front-rear direction. The mating connector includes a mating contact and a mating shell, which has a mating lock portion and a shell contact portion. The connector includes first and second members. The second member has a front portion and a rear portion. The front portion is provided with a lock portion. One of the rear portion and the front portion is provided with a second contact portion. Under a state where the connector and the mating connector are connected with each other, the lock portion locks the mating lock portion while the second contact portion is brought into contact with the shell contact portion, so that the first member and the second member are maintained in a state in which they are electrically separated.

17 Claims, 15 Drawing Sheets



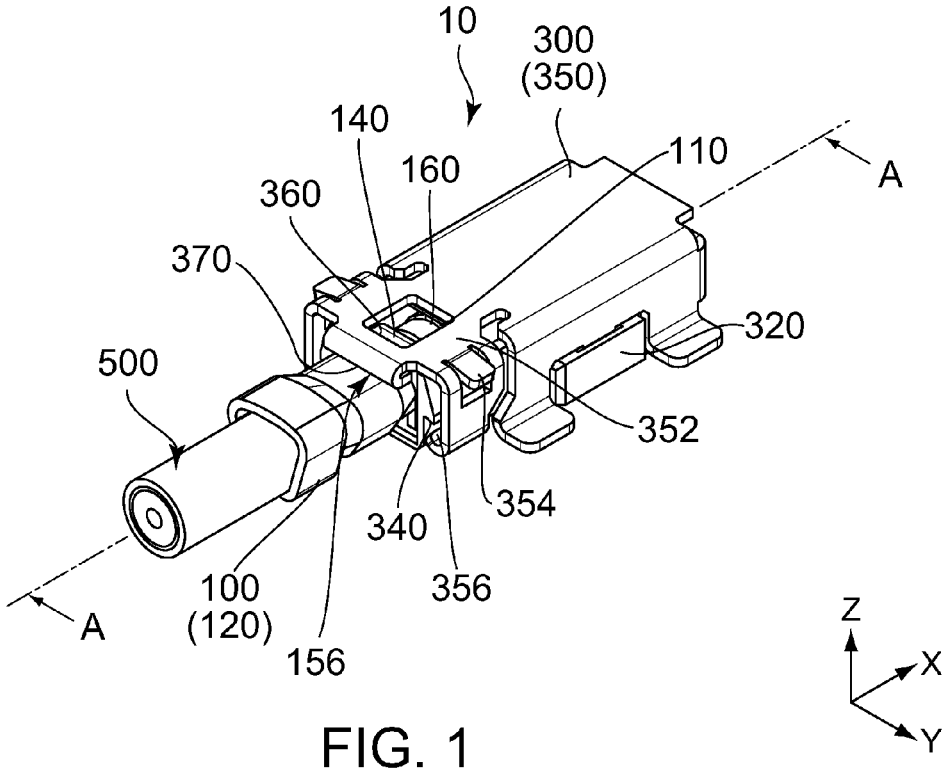

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FIG. 1

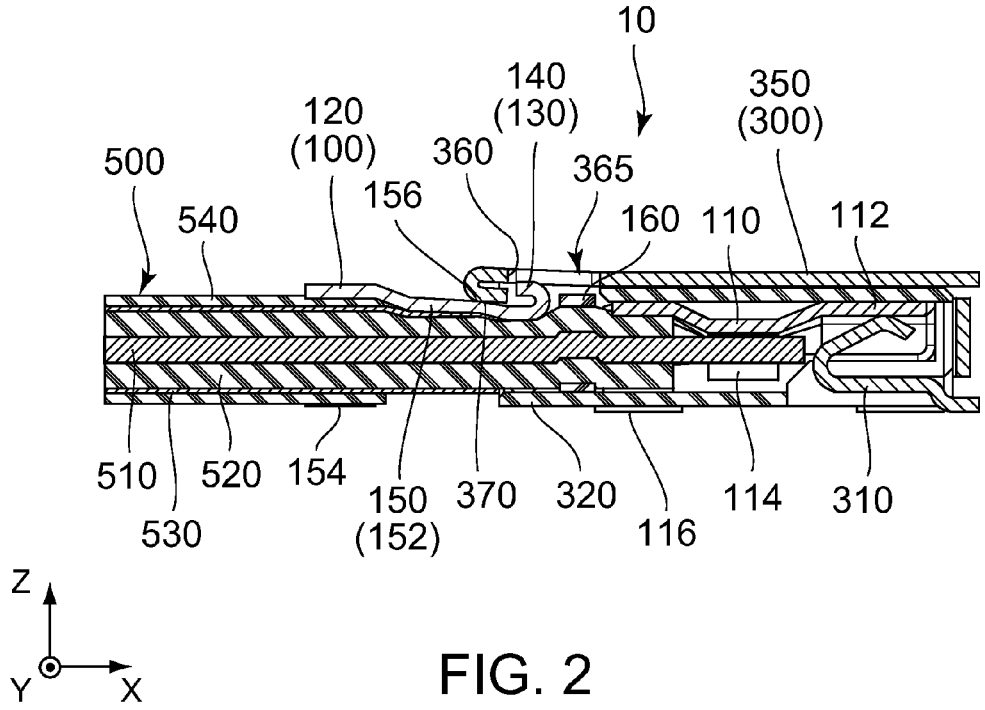
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FIG. 2

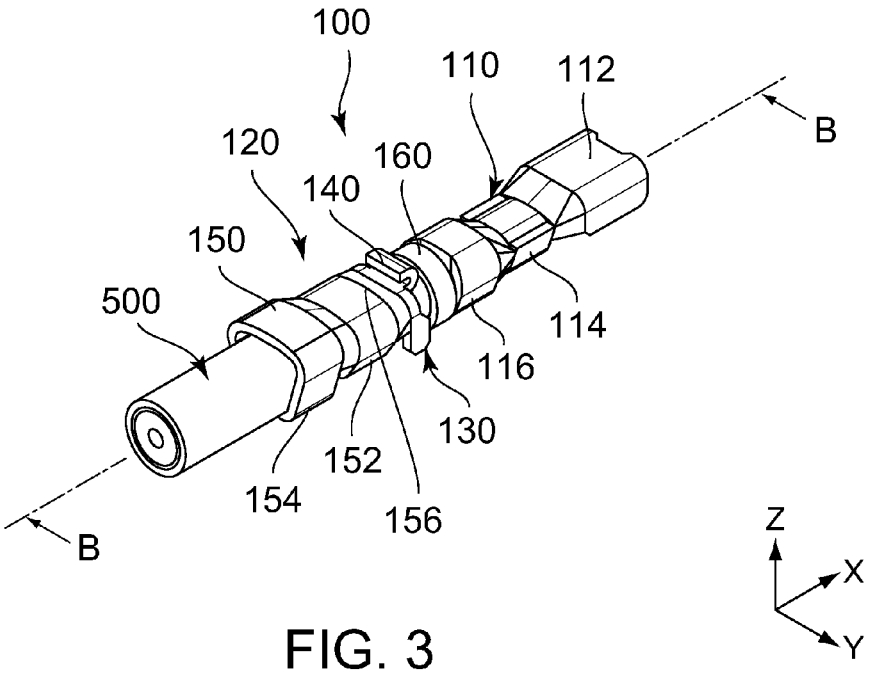
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FIG. 3

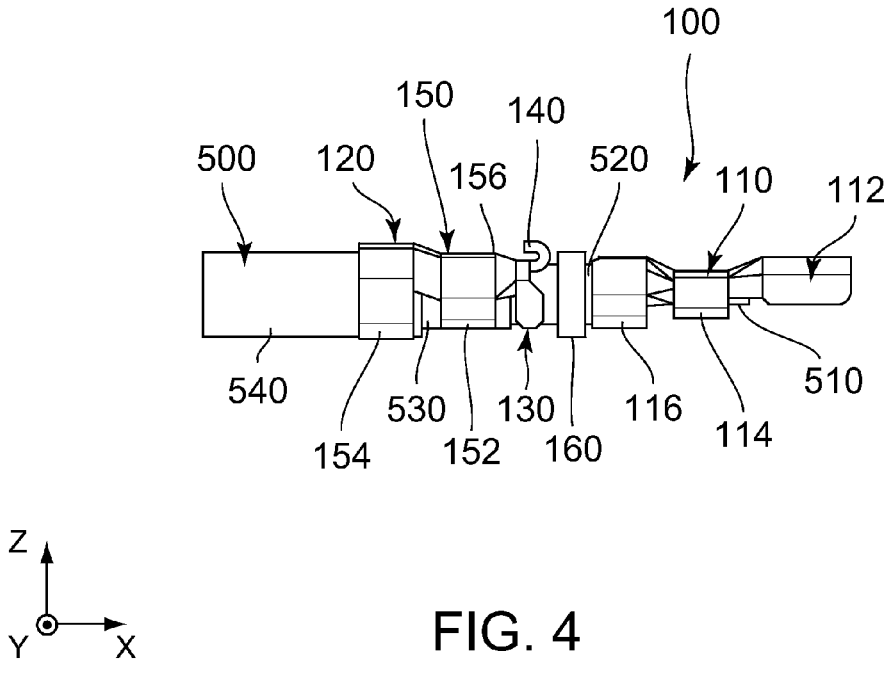
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FIG. 4

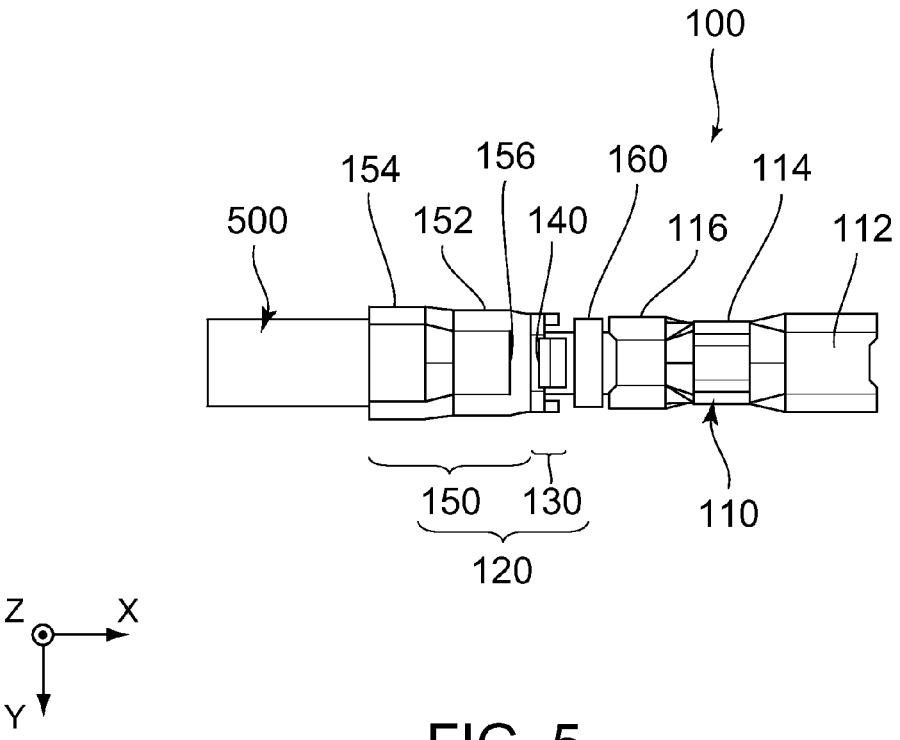
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FIG. 5

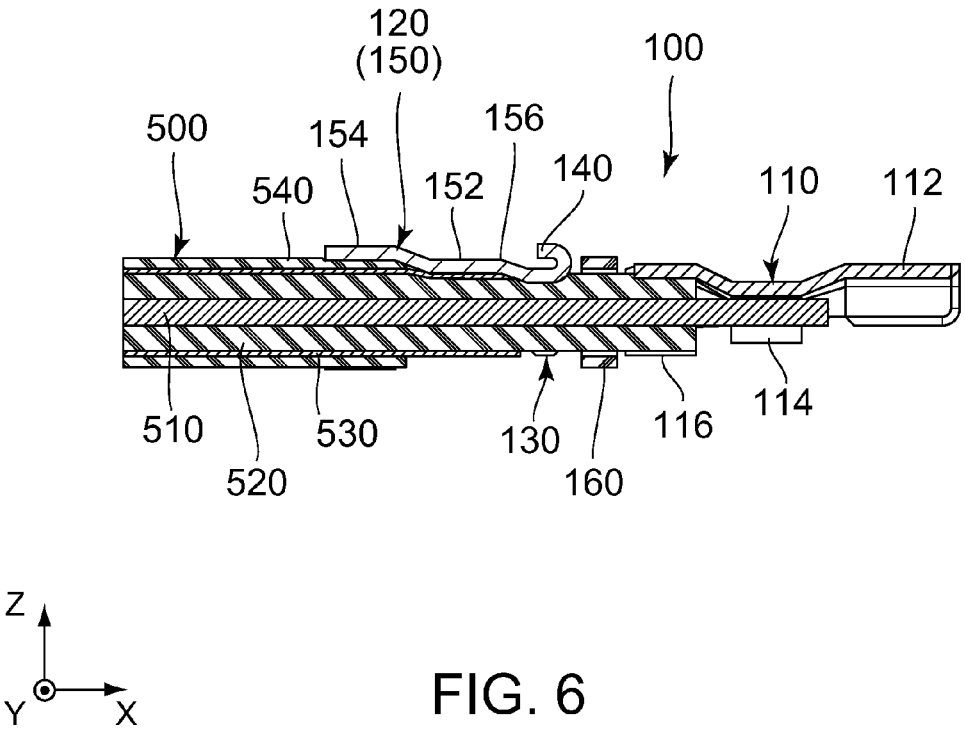
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FIG. 6

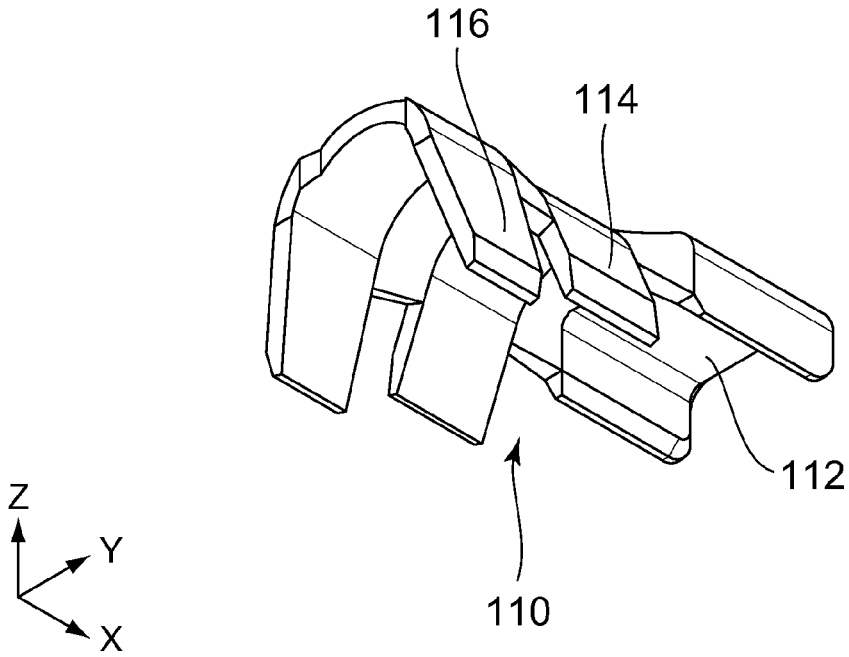
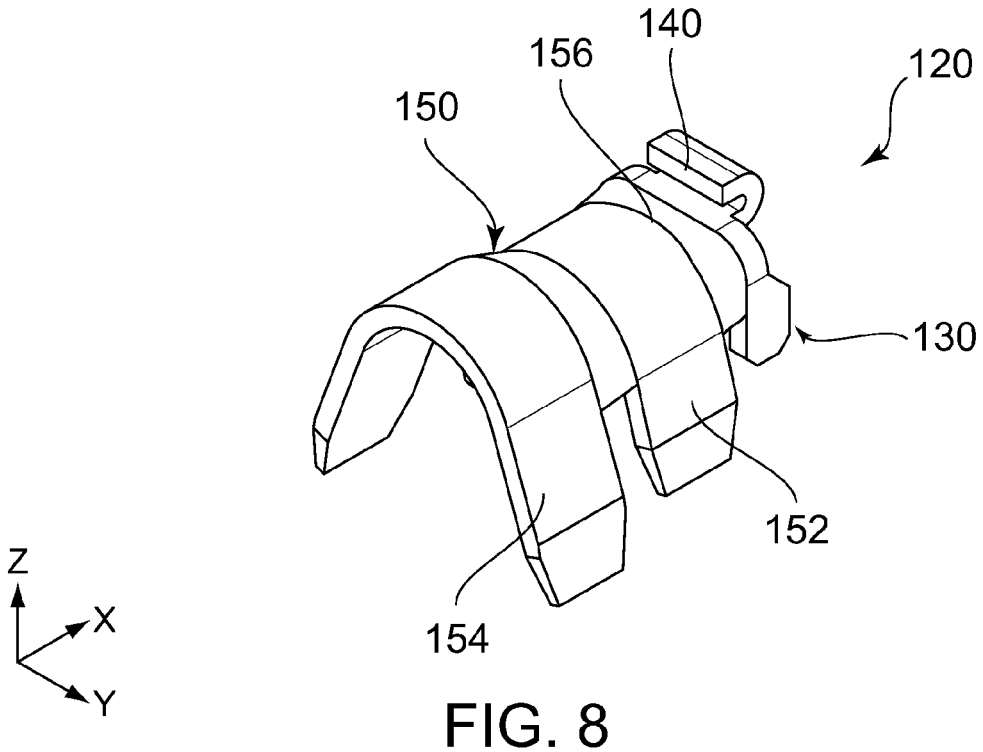


FIG. 7



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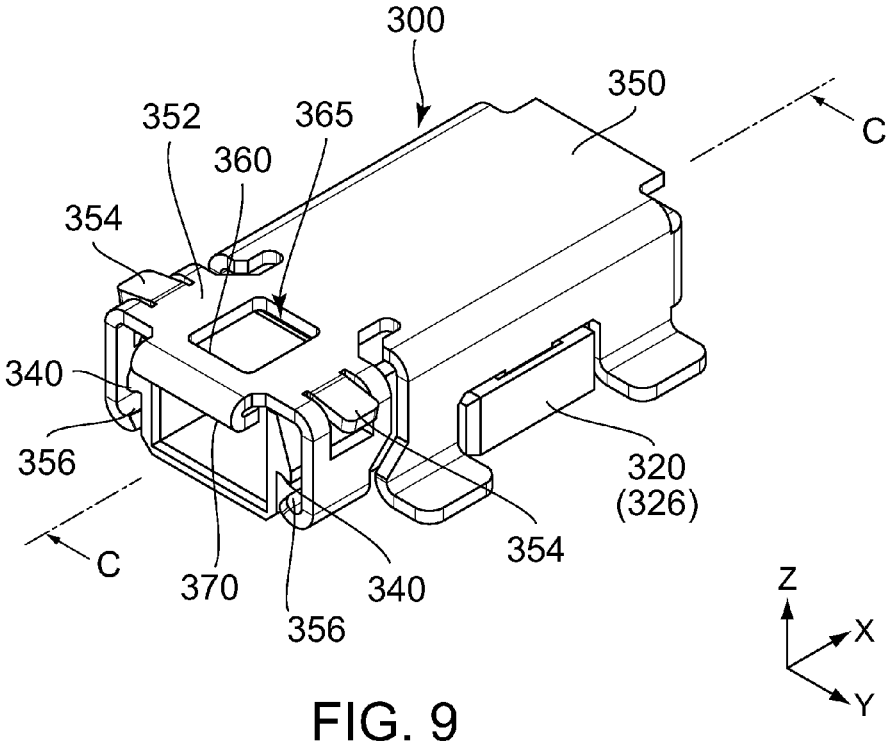
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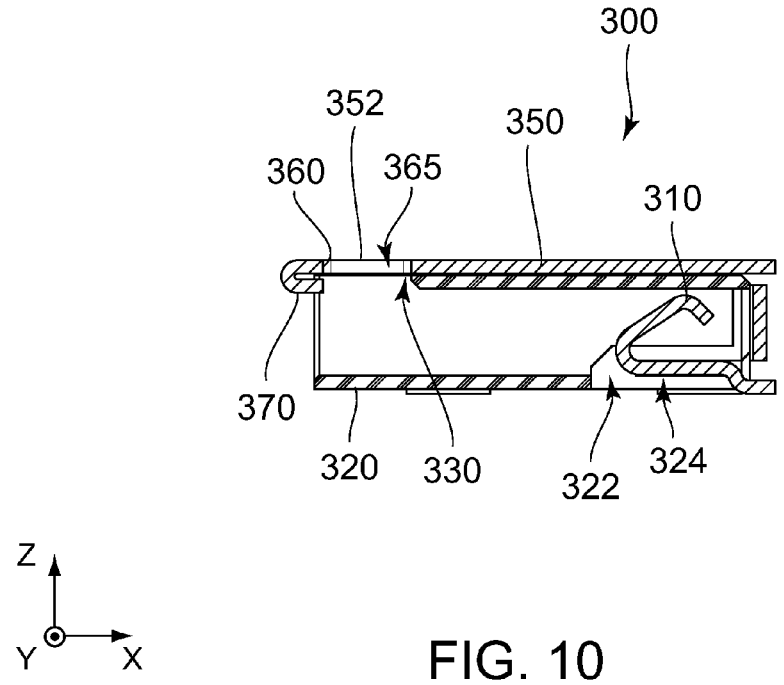
FIG. 9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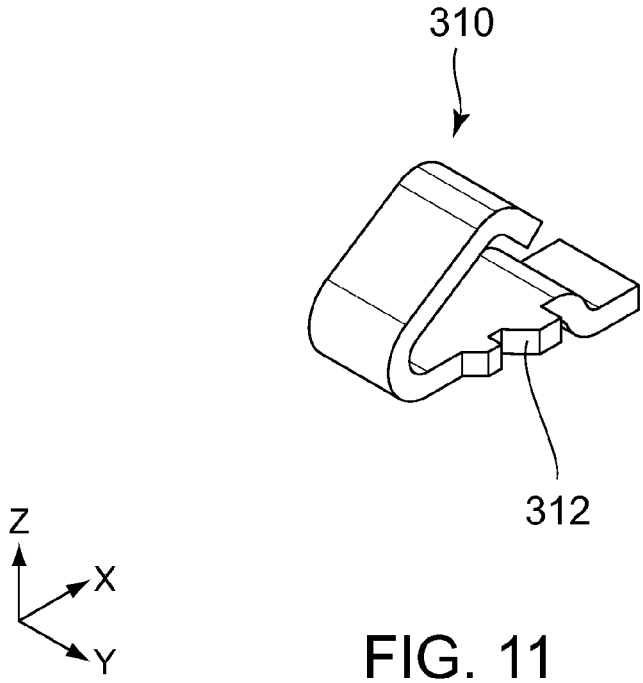

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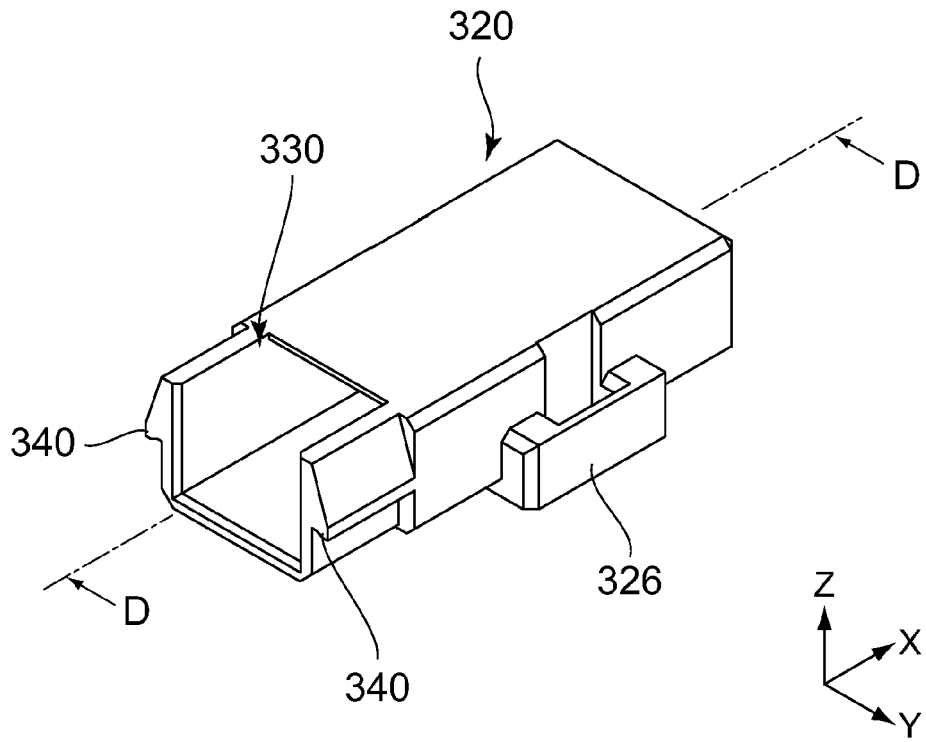
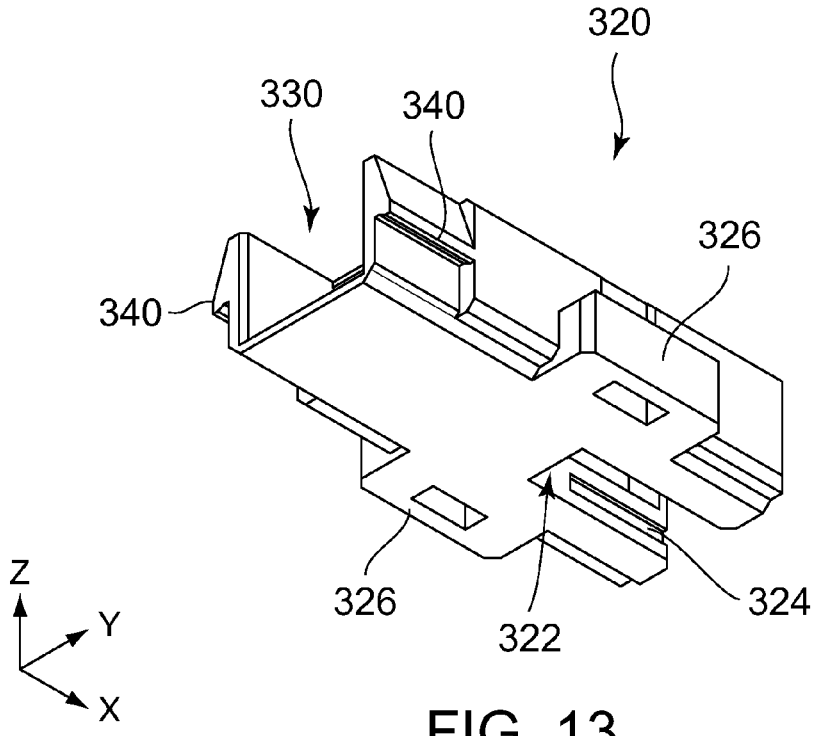


FIG. 12



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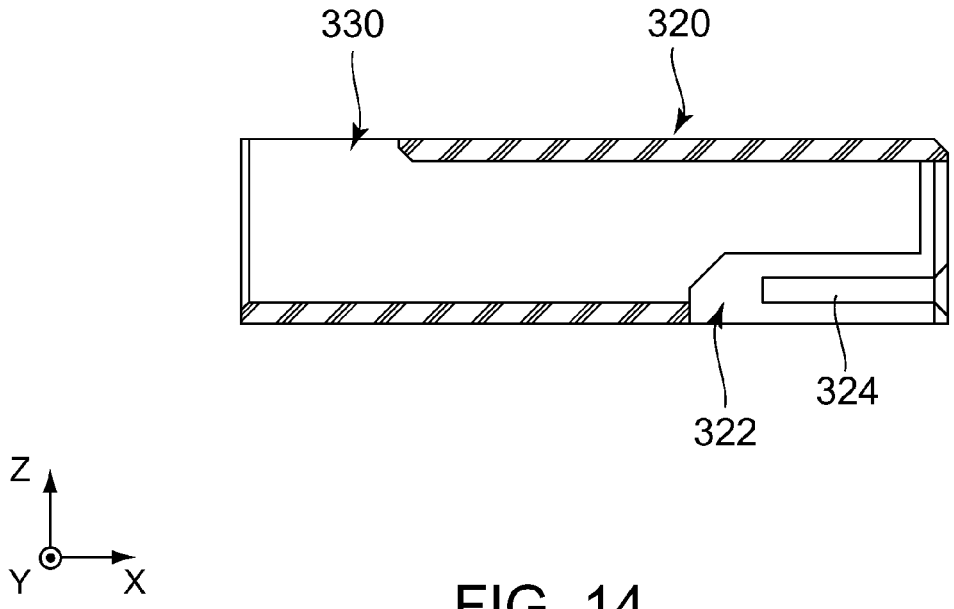

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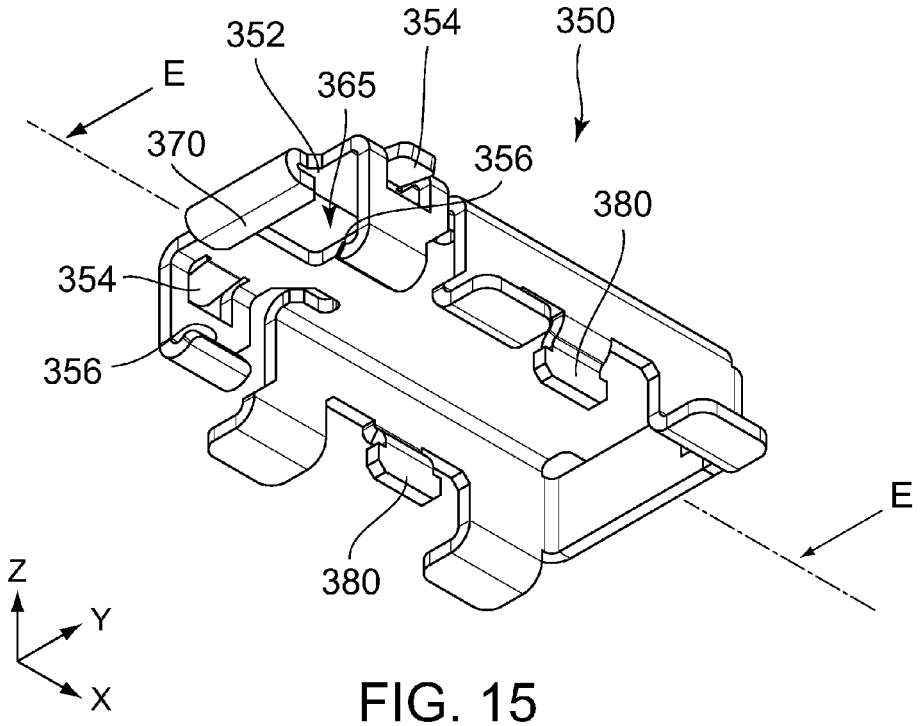
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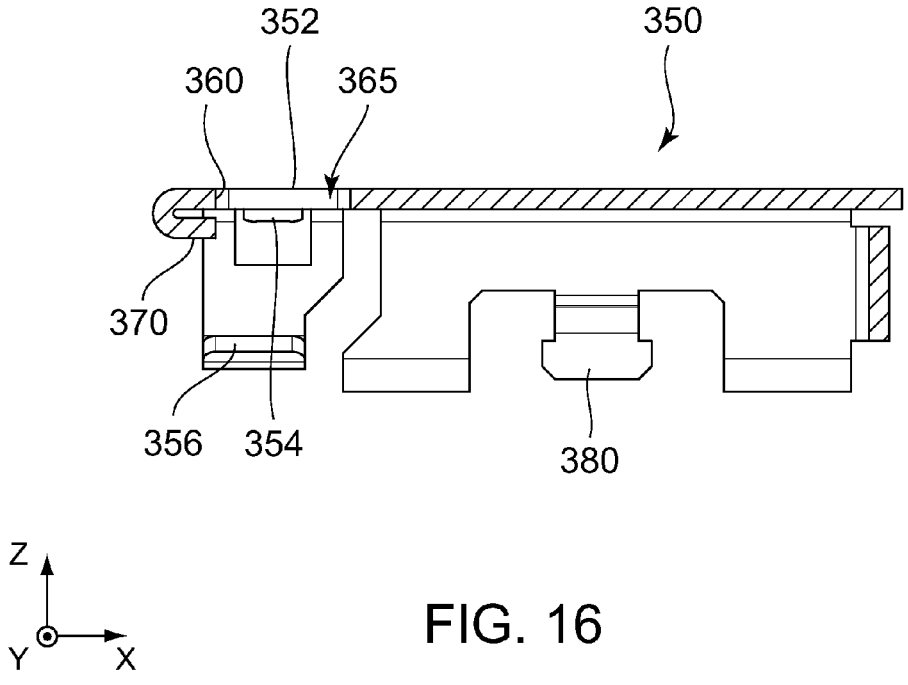
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FIG. 16

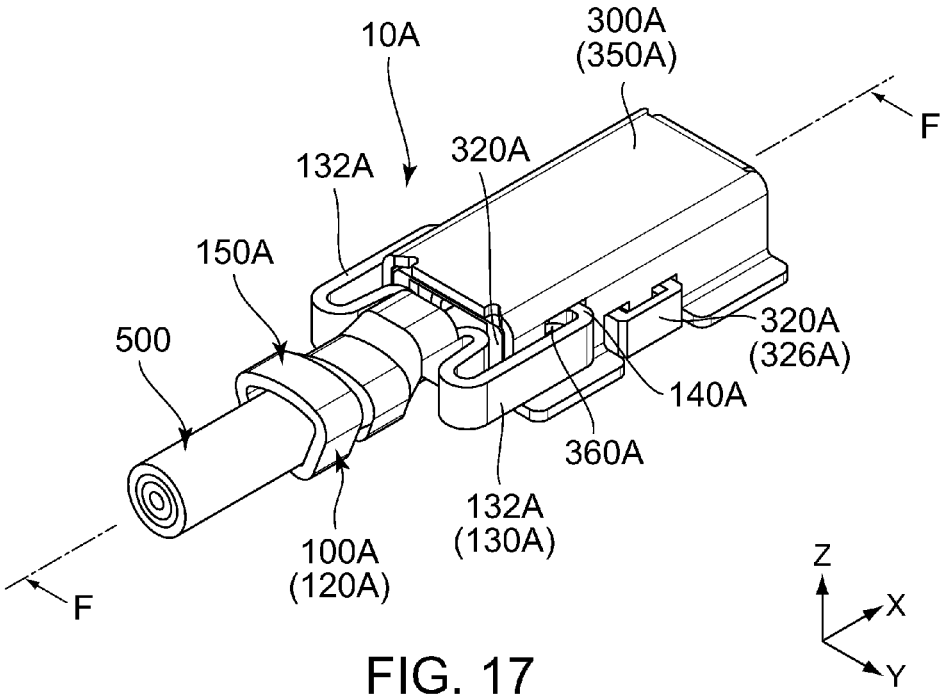
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FIG. 17

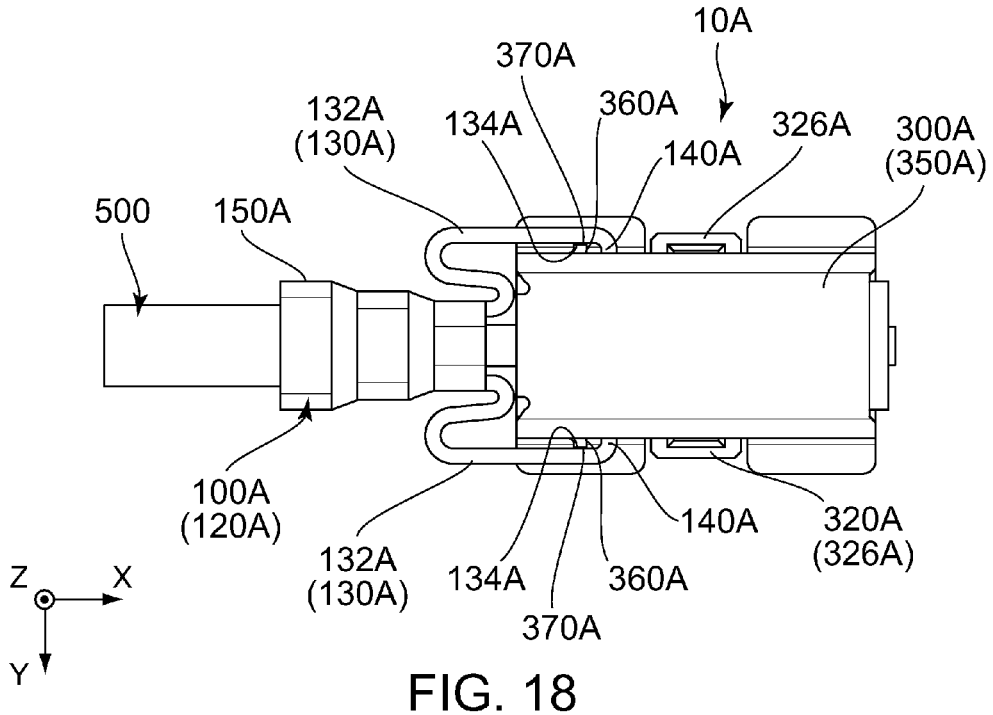
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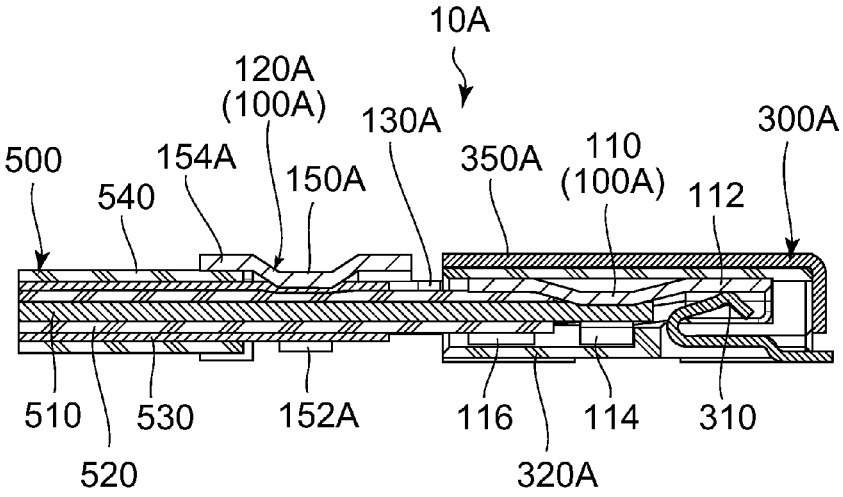
FIG. 18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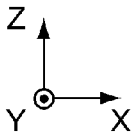
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FIG. 19

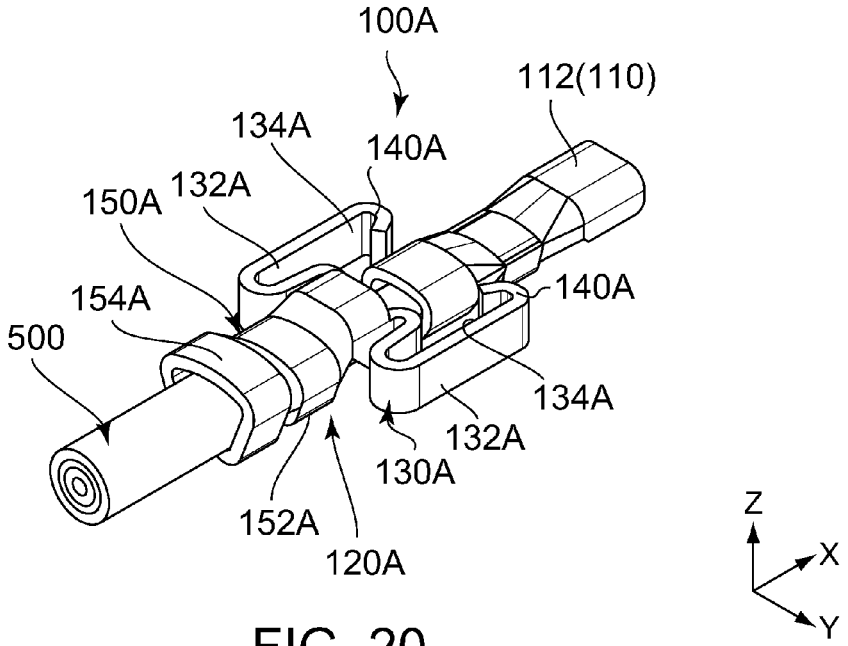
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FIG. 20

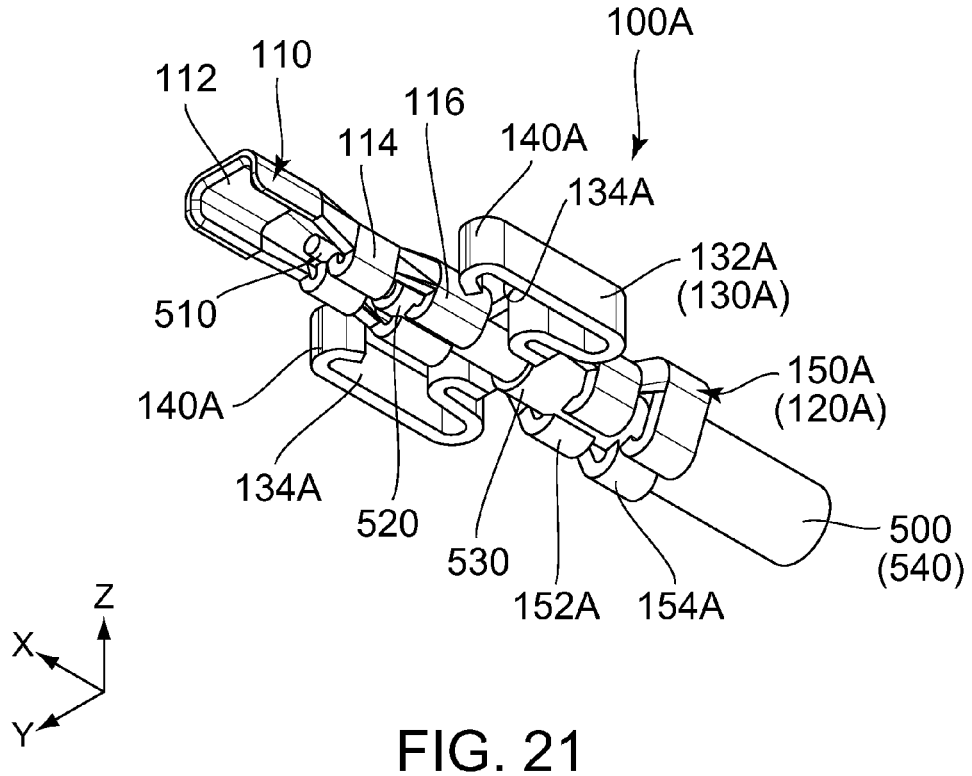
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FIG. 21

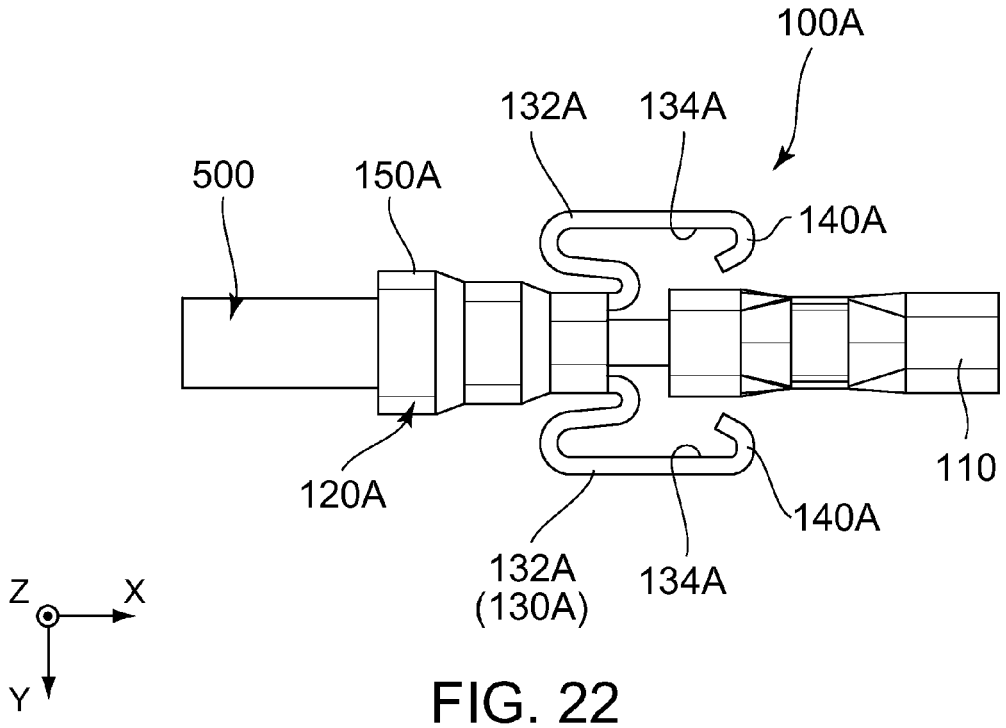
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FIG. 22

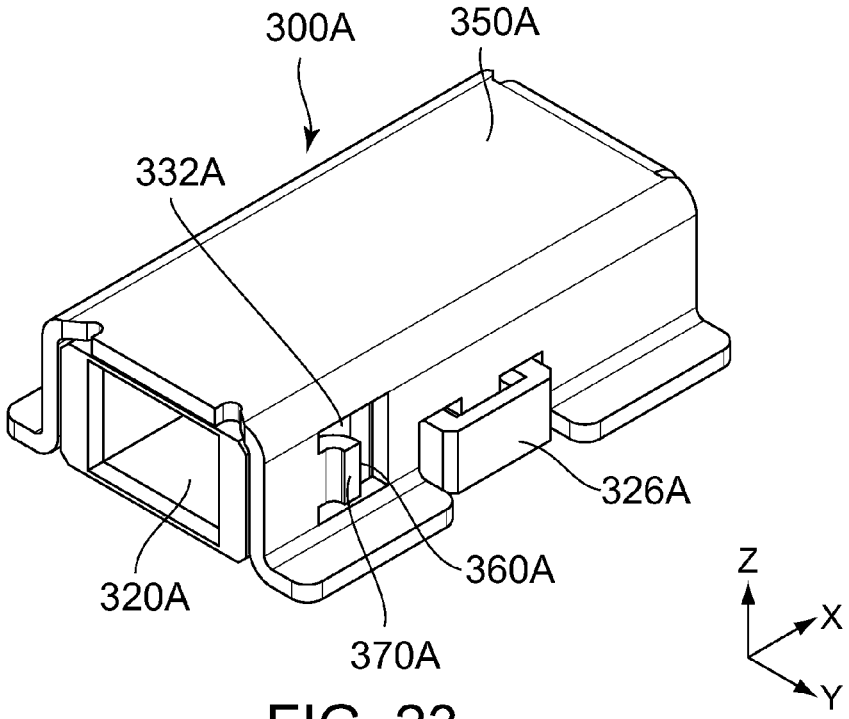
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FIG. 23

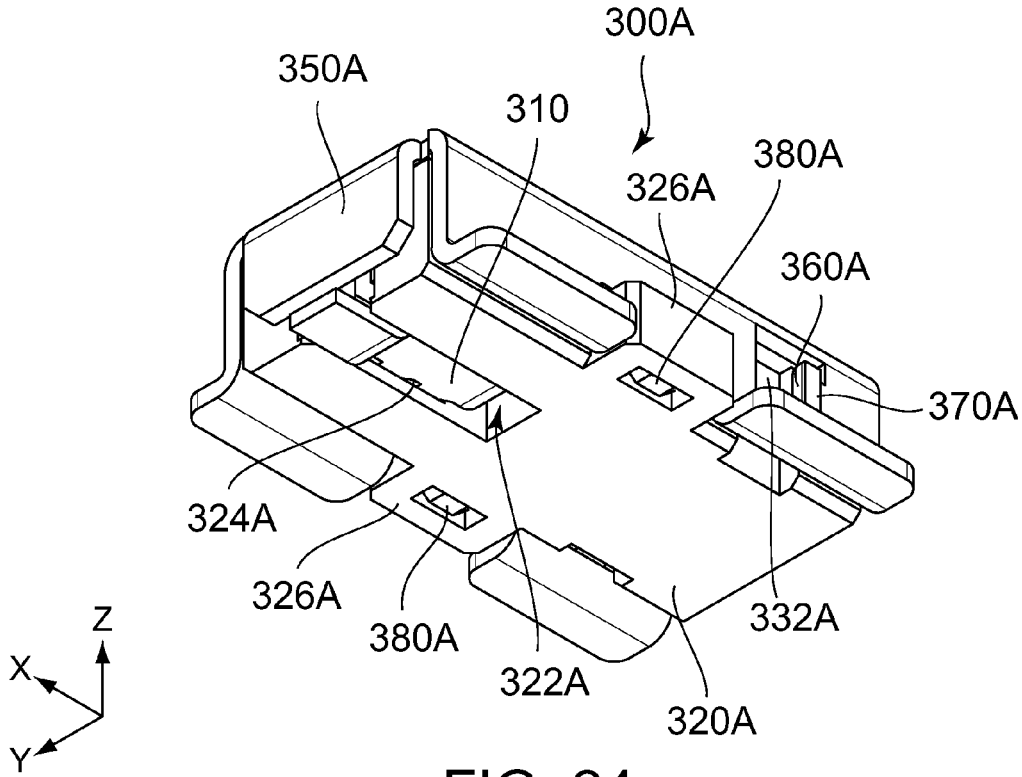
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FIG. 24

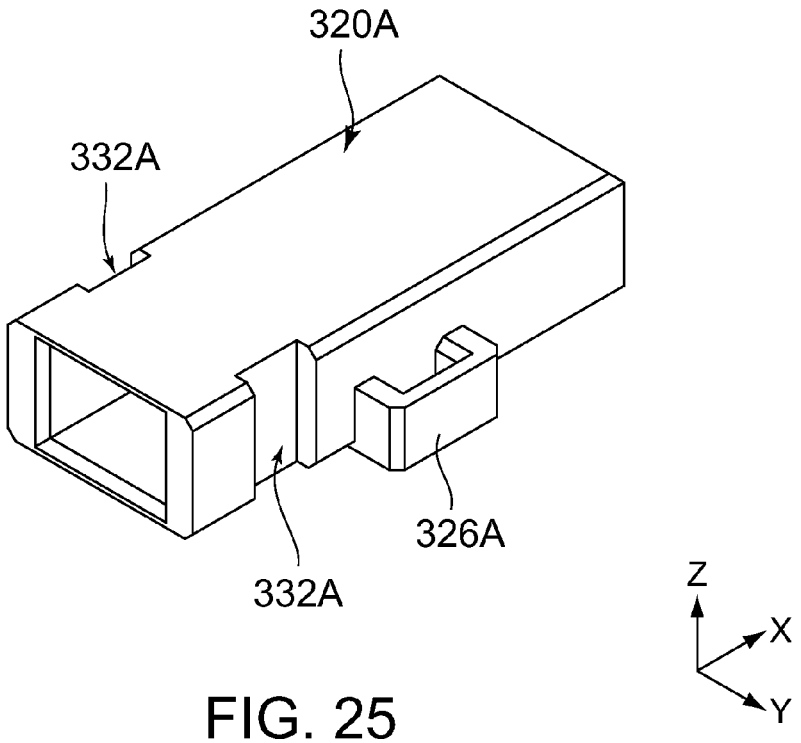
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FIG. 25

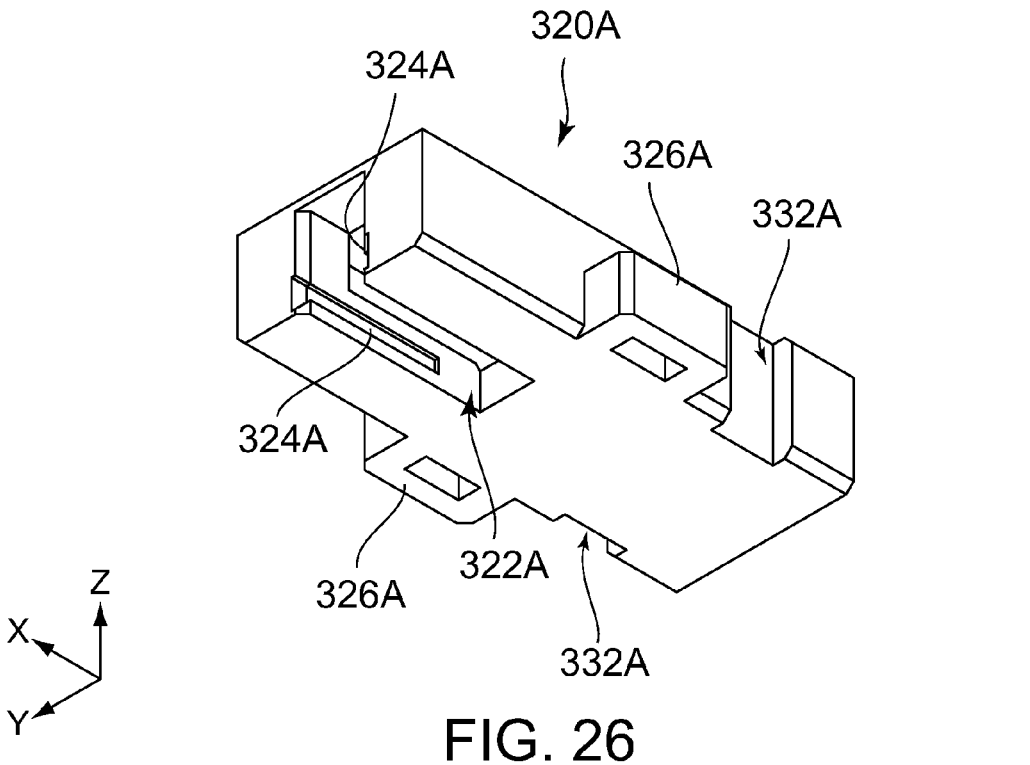
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FIG. 26

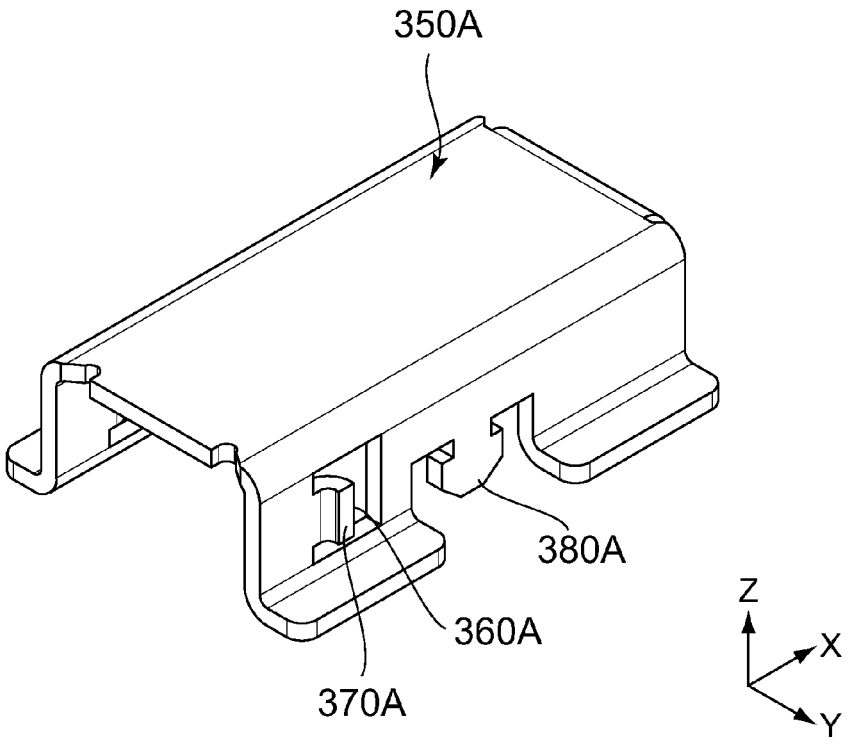

FIG. 27

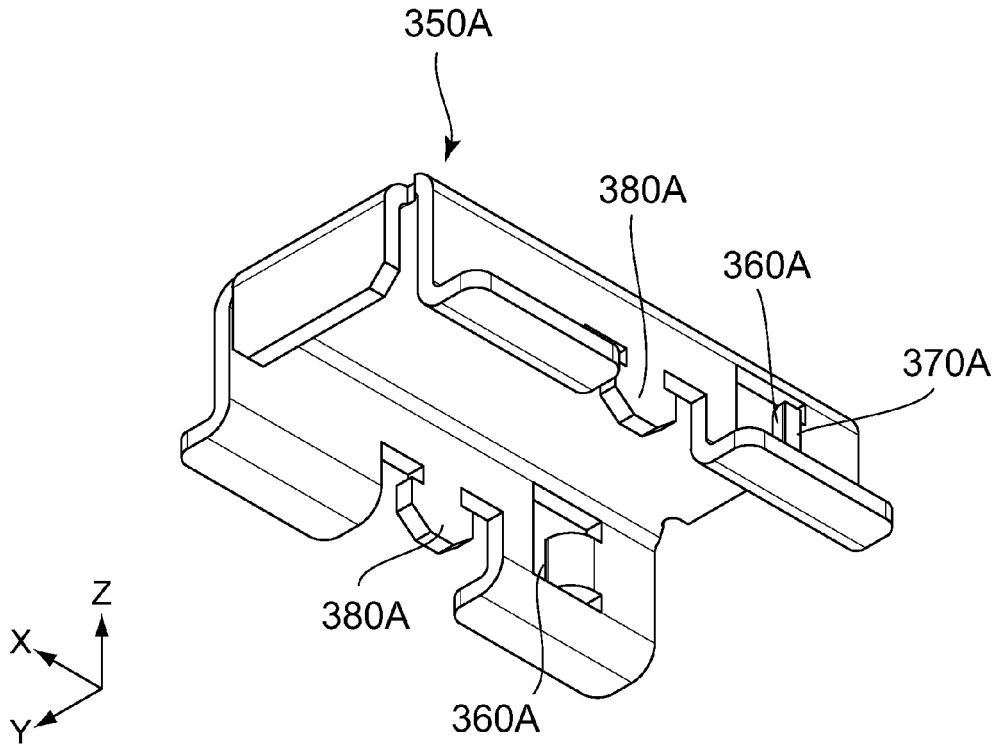

FIG. 28

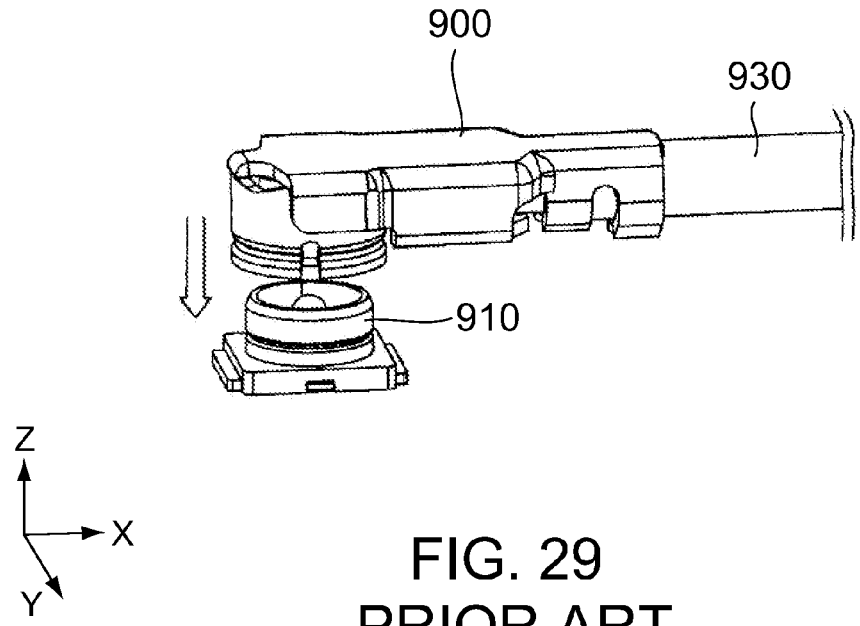

FIG. 29
PRIOR ART

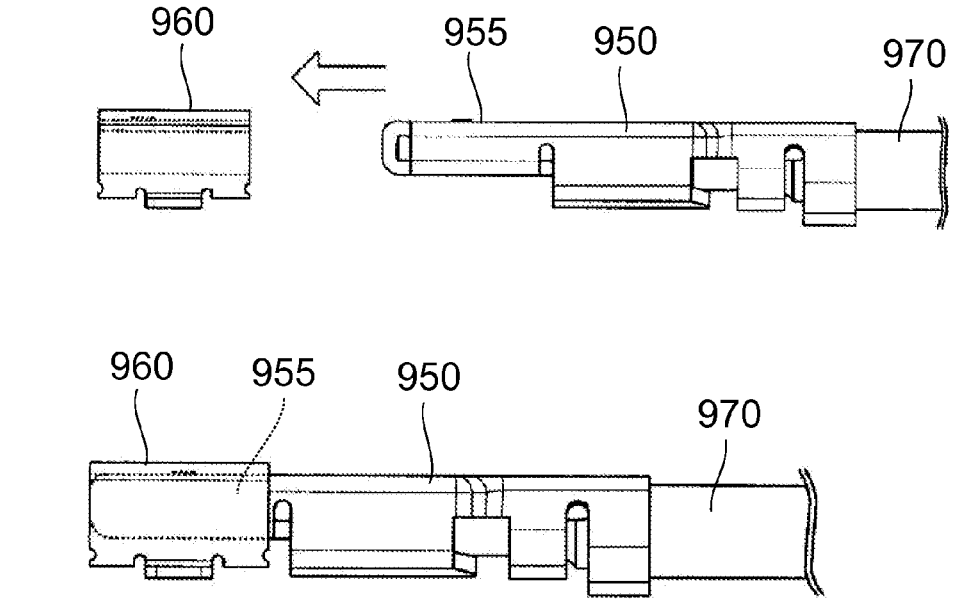

FIG. 30
PRIOR ART

CONNECTOR MATEABLE WITH MATING CONNECTOR AND HAVING FIRST AND SECOND MEMBERS WHICH ARE ELECTRICALLY SEPARATED

CROSS REFERENCE TO RELATED APPLICATIONS

An applicant claims priority under 35 U.S.C. §119 of Japanese Patent Application No. JP2014-152134 filed Jul. 25, 2014.

BACKGROUND OF THE INVENTION

This invention relates to a connector which is connected to a micro coaxial cable or a coaxial cable, and to a connector assembly comprising the connector.

JP-A 2014-72188 (Patent Document 1) describes a prior art connector assembly. As shown in FIG. **29**, the prior art connector assembly of Patent Document 1 comprises a connector **900** and a mating connector **910**. The connector **900** is attached to a cable **930**. The connector **900** and the mating connector **910** are mated with each other in a mating direction, or a Z-direction. The cable **930** extends in an extending direction, or an X-direction. Since the mating direction is perpendicular to the extending direction, the connector **900** is likely to be disconnected from the mating connector **910** if both the connector **900** and the mating connector **910** are miniaturized. In contrast, as shown in FIG. **30**, Patent Document 1 discloses a connector assembly which comprises a connector **950** and a mating connector **960**. The connector has a mating portion **955**. The connector **950** is attached to a cable **970**. The connector **950** and the mating connector **960** are mated with each other in a mating direction, or an X-direction. The cable **970** extends in an extending direction, or the X-direction. Specifically, the mating direction is same as the extending direction. Accordingly, the mating portion **955** can have a sufficient size while the connector **950** can be hardly disconnected from the mating connector **960**.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a connector which is connected to a cable such as a micro coaxial cable or a coaxial cable and which can be further miniaturized. In addition, it is another object of the present invention to provide a connector assembly which includes the above-mentioned connector.

One aspect of the present invention provides a connector attached to a cable which has a center conductor and a shield. The connector is mateable with a mating connector along a front-rear direction. The mating connector comprises a mating contact and a mating shell. The mating shell is provided with a mating lock portion and a shell contact portion. The connector comprises a first member and a second member which is formed separately from the first member. The first member is positioned frontward of the second member in the front-rear direction. The first member has a first connection portion and a first contact portion. The first connection portion is connected to the center conductor. When the connector and the mating connector are connected with each other, the first contact portion is brought into contact with the mating contact. The second member has a front portion and a rear portion which is positioned rearward of the front portion in the front-rear direction. The rear portion is provided with a second connection portion which is connected to the shield. The front portion is provided with a lock portion. One of the rear portion and the front portion is provided with a second contact portion. Under a state where the connector and the mating connector are connected with each other, the lock portion locks the mating lock portion while the second contact portion is brought into contact with the shell contact portion, so that the first member and the second member are maintained in a state where the first member and the second member are electrically separated from each other.

Another aspect of the present invention provides a connector assembly comprising the connector and a mating connector. The first member is positioned apart from the second member in the front-rear direction. The cable comprises an insulator which insulates the center conductor and the shield from each other. The mating shell has a spring portion. The mating lock portion and the shell contact portion are provided at the spring portion. Under a state where the connector and the mating connector are connected with each other, the spring portion presses the shell contact portion against the second contact portion so that the second contact portion is sandwiched between the shell contact portion and the insulator.

The connector of the present invention comprises the first member and the second member which are arranged and separated from each other in the front-rear direction. Furthermore, when the connector and the mating connector are connected with each other, the lock portion of the second member locks the mating lock portion of the mating shell while the second contact portion of the second member is brought into contact with the shell contact portion of the mating shell, so that the first member and the second member are maintained in a state where the first member and the second member are electrically separated from each other. Accordingly, a housing of the connector can be omitted so that an overall size of the connector can be reduced.

An appreciation of the objectives of the present invention and a more complete understanding of its structure may be had by studying the following description of the preferred embodiment and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing a connector assembly which comprise a connector and a mating connector according to a first embodiment of the present invention.

FIG. **2** is a cross-sectional view showing the connector assembly of FIG. **1**, taken along line A-A.

FIG. **3** is a perspective view showing the connector which is included in the connector assembly of FIG. **1**.

FIG. **4** is a side view showing the connector of FIG. **3**.

FIG. **5** is a top view showing the connector of FIG. **3**.

FIG. **6** is a cross-sectional view showing the connector of FIG. **3**, taken along line B-B.

FIG. **7** is a perspective view showing a first member which is included in the connector of FIG. **3**. The illustrated first member is in a state where the first member is not yet attached to the cable.

FIG. **8** is a perspective view showing a second member which is included in the connector of FIG. **3**. The illustrated second member is in a state where the second member is not yet attached to the cable.

FIG. **9** is a perspective view showing the mating connector which is included in the connector assembly of FIG. **1**.

FIG. **10** is a cross-sectional view showing the mating connector of FIG. **9**, taken along line C-C.

FIG. **11** is a perspective view showing a mating contact which is included in the mating connector of FIG. **10**.

FIG. **12** is a perspective view showing a mating housing which is included in the mating connector of FIG. **10**.

FIG. **13** is another perspective view showing the mating housing of FIG. **12**.

FIG. **14** is a cross-sectional view showing the mating housing of FIG. **12**, taken along line D-D.

FIG. **15** is a perspective view showing a mating shell which is included in the mating connector of FIG. **10**.

FIG. **16** is a cross-sectional view showing the mating shell of FIG. **15**, taken along line E-E.

FIG. **17** is a perspective view showing a connector assembly which comprise a connector and a mating connector according to a second embodiment of the present invention.

FIG. **18** is a top view showing the connector assembly of FIG. **17**.

FIG. **19** is a cross-sectional view showing the connector assembly of FIG. **17**, taken along line F-F.

FIG. **20** is a perspective view showing the connector which is included in the connector assembly of FIG. **17**.

FIG. **21** is another perspective view showing the connector of FIG. **20**.

FIG. **22** is a top view showing the connector of FIG. **20**.

FIG. **23** is a perspective view showing the mating connector which is included in the connector assembly of FIG. **17**.

FIG. **24** is another perspective view showing the mating connector of FIG. **23**.

FIG. **25** is a perspective view showing a mating housing which is included in the mating connector FIG. **23**.

FIG. **26** is a perspective view showing the mating housing which is included in the mating connector FIG. **24**.

FIG. **27** is a perspective view showing a mating shell which is included in the mating connector FIG. **23**.

FIG. **28** is a perspective view showing the mating shell which is included in the mating connector FIG. **24**.

FIG. **29** is a view showing a prior art connector assembly described in Patent Document 1.

FIG. **30** is a view showing a connector assembly of Patent Document 1.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DESCRIPTION OF PREFERRED EMBODIMENTS

First Embodiment

With reference to FIGS. **1** and **2**, a connector assembly **10** according to a first embodiment of the present invention comprises a connector **100** and a mating connector **300**. The connector **100** is attached to a cable **500**. The mating connector **300** is to be fixed on an object (not shown) such as a circuit board. The cable **500** which is attached to the connector **100** extends along an extending direction, or a front-rear direction. The connector **100** is connected with the mating connector **300** along a connection direction, or the front-rear direction. The front-rear direction is an X-direction. Specifically, in the present embodiment, the connection direction of the connector **100** and the mating connector **300** is same as the extending direction of the cable **500** which is attached to the connector **100**.

As shown in FIG. **2**, the cable **500** of the present embodiment is a micro coaxial cable. The cable **500** comprises a center conductor **510**, an insulator **520**, a shield **530** and an outer cover (jacket) **540**. The insulator **520** covers the center conductor **510**. The shield **530** is provided on the insulator **520**. The outer cover **540** covers the shield **530**. Specifically, the insulator **520** insulates the center conductor **510** and the shield **530** from each other.

As shown in FIGS. **3** to **6**, the connector **100** comprises a first member **110**, a second member **120** and an insulator member **160**. The first member **110** is made of conductor. The second member **120** is made of conductor. However, each of the first member **110** and the second member **120** may be made of material other than conductor. For example, each of the first member **110** and the second member **120** may be formed of non-conductive material plated with conductor.

The connector **100** according to the present embodiment does not comprise a housing which holds the first member **110**. Accordingly, as described below, the first member **110** and the second member **120** are separated from each other and are independently attached to the cable **500**.

As understood from FIGS. **3** to **6**, the first member **110** is distinct and separated from the second member **120**. The first member **110** is positioned frontward, or toward a positive X-side, of the second member **120** in the front-rear direction. Accordingly, the first member **110** forms an end, or a positive X-side end, of the connector **100**.

In particular, as shown in FIGS. **4** and **5**, the first member **110** is positioned apart from the second member **120** in the front-rear direction. Accordingly, when the connector **100** is connected to the mating connector **300** (see FIG. **1**) so that each of the first member **110** and the second member **120** is appropriately fixed to the mating connector **300**, the first member **110** and the second member **120** are never short-circuited with each other.

As shown in FIG. **6**, the first member **110** has a first contact portion **112**, a first connection portion **114** and an insulator holding portion **116**. The first connection portion **114** is connected to the center conductor **510**. The insulator holding portion **116** holds the insulator **520**. As shown in FIG. **2**, the first contact portion **112** is brought into contact with a mating contact **310** when the connector **100** and the mating connector **300** are connected with each other. Detail description about the mating contact **310** is described later. As shown in FIG. **7**, each of the first connection portion **114** and the insulator holding portion **116** according to the present embodiment has two pieces which roughly face each other in a lateral direction, or a Y-direction. Each of the first connection portion **114** and the insulator holding portion **116** according to the present embodiment is crimped on the cable **500** to be attached thereto. In detail, the first connection portion **114** is crimped on the center conductor **510** to be connected thereto, and the insulator holding portion **116** is crimped on the insulator **520** to hold it.

As shown in FIG. **6**, the second member **120** has a front portion **130** and a rear portion **150**. The rear portion **150** is positioned rearward of the front portion **130** in the front-rear direction.

As shown in FIG. **6**, the rear portion **150** has a second connection portion **152** and an outer cover holding portion **154**. The second connection portion **152** is connected to the shield **530**. The outer cover holding portion **154** holds the outer cover **540**. As understood from FIG. **8**, each of the second connection portion **152** and the outer cover holding portion **154** according to the present embodiment has two pieces which roughly face each other in the lateral direction, or the Y-direction. Each of the second connection portion **152** and the outer cover holding portion **154** according to the present embodiment is crimped on the cable **500** to be attached thereto. In detail, the second connection portion **152** is crimped on the shield **530** to be connected thereto, and the outer cover holding portion **154** is crimped on the outer cover **540** to hold it.

As described later, a part of the rear portion **150** of the present embodiment functions as a second contact portion **156** which is brought into contact with a part of the mating connector **300**. However, the present invention is not limited thereto. For example, the second contact portion **156** may be provided on the front portion **130**.

As shown in FIG. **8**, the front portion **130** is provided with a lock portion **140**. As described later, under a connection state where the connector **100** and the mating connector **300** are connected with each other, the lock portion **140** locks a part of the mating connector **300** to maintain the connection state. The lock portion **140** is positioned frontward of the second contact portion **156** in the front-rear direction. In the present embodiment, the lock portion **140** forms an end, or a positive X-side end, of the second member **120**. In addition, a whole of the front portion **130** of the present embodiment is positioned frontward of the second connection portion **152** in the front-rear direction. Accordingly, when the second connection portion **152** is crimped on the shield **530**, the front portion **130** provides no obstacle to the crimping operation of the second connection portion **152**. Similarly, when the outer cover holding portion **154** is crimped on the outer cover **540**, the front portion **130** provides no obstacle to the crimping operation of the outer cover holding portion **154**.

As shown in FIGS. **4** and **6**, the lock portion **140** of the present embodiment is positioned slightly above, or toward a positive Z-side of, the outer cover holding portion **154**. A height, or a size in the Z-direction, of the connector **100** is mainly determined by an external diameter of the outer cover **540** of the cable **500**. In order to minimize the height of the connector **100**, it is preferable that an upper end of the outer cover holding portion **154** is positioned at an uppermost part of the second member **120** in an up-down direction, or in the Z-direction, while a whole of the front portion **130** is positioned below, or toward a negative Z-side of, the outer cover holding portion **154** in the up-down direction.

As understood from FIGS. **3** to **5**, the second member **120** of the present embodiment has only the front portion **130** and the rear portion **150**. The second member **120** of the present embodiment does not have, for example, a function similar to that of a shell which surrounds the first member **110** in a plane, or a YZ-plane, perpendicular to the front-rear direction. In addition, as understood from FIG. **5**, the first member **110** does not overlap the second member **120** so that the first member **110** is visible when the first member **110** is seen along the up-down direction under a state where the first member **110** and the second member **120** are attached to the cable **500**.

As shown in FIGS. **3** to **6**, the insulator member **160** is positioned between the first member **110** and the second member **120** in the front-rear direction while being positioned so as to surround the insulator **520** of the cable **500**. The insulator member **160** of the present embodiment is formed by separating a part of the outer cover **540**. Specifically, the insulator member **160** of the present embodiment is formed by using the part of the outer cover **540** which is to be discarded. Accordingly, material cost of the connector **100** never increases even if the connector **100** is provided with the insulator member **160**. In the present embodiment, the first member **110** and the second member **120** are arranged not to be short-circuited with each other without being provided with the insulator member **160**. In a case where the connector **100** is provided with the insulator member **160**, the first member **110** and the second member **120** can be more securely prevented from being short-circuited with each other. The insulator member **160** may be formed by using a member other than the part of the outer cover **540** which is separated therefrom. In that case, in order to securely prevent the first member **110** and the second member **120** from being short-circuited with each other, it is preferable, for example, that the insulator member **160** is arranged not to be moved frontward beyond a rear end, or a negative X-side end, of the first member **110**. Specifically, it is preferable that a first area is smaller than a second area, wherein the insulator member **160** has an inner periphery, the first area is defined by the inner periphery in a plane perpendicular to the front-rear direction, the first member **110** has the rear end attached to the cable **500**, and the second area is a total area of a cross-section of the rear end and a cross-section of the cable **500** in a plane perpendicular to the front-rear direction.

As understood from FIGS. **9** and **10**, the mating connector **300** comprises a mating contact **310**, a mating housing **320** and a mating shell **350**. The mating contact **310** is made of conductor. The mating housing **320** is made of insulator. The mating shell **350** is made of metal. As shown in FIG. **11**, the mating contact **310** is provided with a press-fit portion **312**. The mating contact **310** is connected to the first member **110** under the connection state where the connector **100** (see FIG. **1**) and the mating connector **300** are connected with each other. Although the mating contact **310** of the present embodiment is made of conductor, the mating contact **310** may be formed of non-conductive material plated with conductor similar to the first member **110** and the second member **120**. The mating shell **350** may be made of material other than metal, provided that the mating shell **350** made of the material electromagnetically shields the mating contact **310** and the first member **110** under a connection state where the mating contact **310** and the first member **110** are connected with each other.

As shown in FIGS. **12** to **14**, the mating housing **320** has a substantially rectangular tube-like shape. As shown in FIGS. **13** and **14**, the mating housing **320** is provided with a lower recess **322**. The lower recess **322** has two inner walls which face each other in the lateral direction. When the press-fit portion **312** (see FIG. **11**) of the mating contact **310** is press-fitted into the lower recess **322**, the two inner walls function as contact holding portions **324**, respectively, which hold the mating contact **310**. As shown in FIG. **13**, the mating housing **320** is further formed with two shell holding portions **326**, an upper recess **330** and two first regulating portions **340**. Each of the shell holding portions **326** projects outward in the lateral direction. As described later, the shell holding portions **326** hold parts of the mating shell **350**, respectively. The upper recess **330** is formed at a side of the mating housing **320** which is opposite, in both the up-down direction and the front-rear direction, to another side thereof where the lower recess **322** is positioned. The first regulating

portions **340** are formed at opposite ends, respectively, of the mating housing **320** in the lateral direction. Each of the first regulating portions **340** is located at a position almost same as that of the upper recess **330** in the front-rear direction. Each of the first regulating portions **340** has a barb-like shape in the plane, or the YZ-plane, perpendicular to the front-rear direction and extends in the front-rear direction.

As shown in FIGS. **9**, **15** and **16**, the mating shell **350** is provided with a spring portion **352** and two press-fit portions **380**. The spring portion **352** is resiliently deformable. As understood from FIGS. **9** and **10**, when the press-fit portions **380** are press-fitted into the shell holding portions **326**, respectively, the spring portion **352** is positioned above the upper recess **330**. Accordingly, the spring portion **352** is resiliently deformable without being regulated by the mating housing **320**. As shown in FIGS. **9**, **15** and **16**, the spring portion **352** is formed with an opening **365**. A negative X-side edge of the opening **365** functions as a mating lock portion **360**. An end, or a negative X-side end, of the spring portion **352** is folded back to form a shell contact portion **370**. Thus, the mating shell **350** is provided with the mating lock portion **360** and the shell contact portion **370**. Specifically, the shell contact portion **370** of the present embodiment is positioned toward a negative X-side of the mating lock portion **360**. Tabs **354** and second regulating portions **356** are provided at opposite ends of the spring portion **352** in the lateral direction, respectively. Each of the tabs **354** projects outward in the lateral direction. Each of the second regulating portions **356** has a J-shaped cross section in the plane, or the YZ-plane, perpendicular to the front-rear direction. As expected from FIG. **9**, when the tabs **354** are moved upward by using a jig, the spring portion **352** can be forcibly bent. If the spring portion **352** is excessively bent, the spring portion **352** may be excessively deformed. In the present embodiment, when the spring portion **352** is about to be excessively bent, the second regulating portions **356** abut the first regulating portions **340**, respectively. Accordingly, the spring portion **352** is prevented from being excessively deformed.

As understood from FIGS. **1** to **3**, **6**, **9** and **10**, when the first member **110** of the connector **100** is inserted into the mating connector **300** along the front-rear direction so that the connector **100** and the mating connector **300** are connected with each other, the first contact portion **112** of the first member **110** is brought into contact with the mating contact **310** while the shell contact portion **370** is brought into contact with the second contact portion **156**. In particular, in the present embodiment, under the connection state where the connector **100** and the mating connector **300** are connected with each other, the second contact portion **156** is brought into contact with the shell contact portion **370** from an inside of the mating connector **300** as shown in FIG. **2**. At that time, the lock portion **140** is positioned in the opening **365** while locking the mating lock portion **360** so that the connection state of the connector **100** and the mating connector **300** is maintained. In detail, under the connection state where the connector **100** and the mating connector **300** are connected with each other, the spring portion **352** (see FIG. **1**) presses the shell contact portion **370** against the second contact portion **156** so that the second contact portion **156** is sandwiched between the shell contact portion **370** and the insulator **520**. At that time, the first member **110** and the second member **120** are maintained in a state where the first member **110** and the second member **120** are electrically separated from each other as apparent from FIGS. **1** and **2**. Accordingly, in the connector **100** of the present embodiment, the first member **110** and the second member **120** can be prevented from being short-circuited with each other without being provided with a housing. Thus, the height of the connector **100** can be lowered so that the connector assembly **10** can be reduced in height.

Under the connection state where the connector **100** and the mating connector **300** are connected with each other as shown in FIG. **1**, when the tabs **354** are moved upward to be pulled or pushed up by using the jig (not shown) so that the spring portion **352** is resiliently deformed, a lock of the lock portion **140** against the mating lock portion **360** can be released as understood from FIG. **2**. Accordingly, the connector **100** can be released from the mating connector **300**. Thus, the connector assembly **10** according to the present embodiment has a structure in which the connector **100** is repeatedly insertable into the mating connector **300**.

In the aforementioned embodiment, the second contact portion **156** is brought into contact with the shell contact portion **370** from the inside of the mating connector **300**. The second contact portion **156** may however be brought into contact with the shell contact portion **370** from an outside of the mating connector **300**. In that case, the connector **100** has an increased height. In a case where the connector **100** is provided with the first member **110** and the second member **120** so that the first member **110** and the second member **120** do not overlap each other in the front-rear direction similar to the present embodiment, it is preferable that the second contact portion **156** is brought into contact with the shell contact portion **370** from the inside of the mating connector **300**.

Second Embodiment

With reference to FIGS. **17** to **19**, a connector assembly **10**A according to a second embodiment of the present invention comprises a connector **100**A and a mating connector **300**A. The connector **100**A is attached to the cable **500**. The mating connector **300**A is to be fixed on an object (not shown) such as a circuit board. The connector **100**A and the mating connector **300**A are connected with each other in a connection direction. The cable **500** which is attached to the connector **100**A extends in an extending direction. Similar to the aforementioned first embodiment, each of the connection direction and the extending direction of the present embodiment is the front-rear direction, or the X-direction. In other words, the connection direction and the extending direction are same as each other. In addition, the cable **500** of the present embodiment is same as that of the aforementioned first embodiment. Accordingly, detail description about the cable **500** of the present embodiment is omitted.

As shown in FIGS. **20** to **22**, the connector **100**A comprises a first member **110** and a second member **120**A. The first member **110** is made of conductor. The second member **120**A is made of conductor. The first member **110** of the present embodiment is same as that of the aforementioned first embodiment. Accordingly, detail description about the first member **110** of the present embodiment is omitted. Each of the first member **110** and the second member **120**A may not be made of conductor. For example, each of the first member **110** and the second member **120**A may be formed of non-conductive material plated with conductor.

Similar to the connector **100** of the first embodiment, the connector **100**A according to the present embodiment does not comprise a housing which holds the first member **110**. Accordingly, the first member **110** and the second member **120**A are separated from each other and are independently attached to the cable **500**.

As shown in FIGS. **20** to **22**, the second member **120**A is positioned rearward of the first member **110** in the front-rear direction. The second member **120**A has a front portion **130**A and a rear portion **150**A. The rear portion **150**A is positioned rearward of the front portion **130**A.

As understood from FIGS. **20** to **22** and FIGS. **3** to **5**, the rear portion **150**A of the present embodiment has a structure essentially same as that of the rear portion **150** of the aforementioned first embodiment. Specifically, the rear portion **150**A has a second connection portion **152**A and an outer cover holding portion **154**A. The second connection portion **152**A is connected to the shield **530**. The outer cover holding portion **154**A holds the outer cover **540**. As understood from FIG. **21**, the second connection portion **152**A is crimped on the shield **530** to be connected thereto, and the outer cover holding portion **154**A is crimped on the outer cover **540** to hold it. Although the second contact portion **156** of the first embodiment is a part of the rear portion **150**, second contact portions **134**A of the present embodiment are not provided at the rear portion **150**A as described later.

As shown in FIGS. **20** to **22**, the front portion **130**A is provided with spring portions **132**A and lock portions **140**A. Each of the spring portions **132**A is resiliently deformable. The lock portions **140**A are supported by the spring portions **132**A, respectively. As described later, under a connection state where the connector **100**A and the mating connector **300**A are connected with each other, the lock portions **140**A lock parts of the mating connector **300**A, respectively, so that the connector **100**A and the mating connector **300**A are maintained in the connection state. As described later, parts of the spring portions **132**A function as the second contact portions **134**A which are brought into contact with parts of the mating connector **300**A, respectively. The lock portions **140**A are positioned frontward of the second contact portions **134**A in the front-rear direction, respectively. In the present embodiment, each of the lock portions **140**A constitutes an end, or a positive X-side end, of the second member **120**A. In addition, as shown in FIGS. **20** and **21**, a whole of the front portion **130**A of the present embodiment is positioned frontward of the second connection portion **152**A in the front-rear direction. Accordingly, when the second connection portion **152**A is crimped on the shield **530**, the front portion **130**A provides no obstacle to the crimping operation of the second connection portion **152**A. Similarly, when the outer cover holding portion **154**A is crimped on the outer cover **540**, the front portion **130**A provides no obstacle to the crimping operation of the outer cover holding portion **154**A.

As understood from FIG. **19**, in the present embodiment, an upper end of the outer cover holding portion **154**A is positioned at an uppermost part of the second member **120**A in the up-down direction, or the Z-direction, while a whole of the front portion **130**A is positioned below, or toward a negative Z-side of, the outer cover holding portion **154**A in the up-down direction.

As understood from FIGS. **20** to **22**, the second member **120**A of the present embodiment has only the front portion **130**A and the rear portion **150**A. Specifically, similar to the second member **120** of the first embodiment, the second member **120**A of the present embodiment does not have a function similar to that of a shell which surrounds the first member **110** in the plane, or the YZ-plane, perpendicular to the front-rear direction. In addition, as understood from FIG. **22**, the first member **110** does not overlap the second member **120**A so that the first member **110** is visible when the first member **110** is seen along the up-down direction under a state where the first member **110** and the second member **120**A are attached to the cable **500**.

As understood from FIGS. **23** and **24**, the mating connector **300**A comprises a mating contact **310**, a mating housing **320**A and a mating shell **350**A. The mating contact **310** is made of conductor. The mating housing **320**A is made of insulator. The mating shell **350**A is made of metal. In essential structure and function, the mating contact **310** of the present embodiment is similar to the mating contact **310** of the aforementioned first embodiment. Accordingly, detail description about the mating contact **310** of the present embodiment is omitted.

As shown in FIGS. **25** and **26**, the mating housing **320**A has a substantially rectangular tube-like shape. As shown in FIGS. **24** and **26**, the mating housing **320**A is provided with a lower recess **322**A. The lower recess **322**A has two inner walls which face each other in the lateral direction. When the press-fit portion **312** (see FIG. **11**) of the mating contact **310** is press-fitted into the lower recess **322**A, the two inner walls function as contact holding portions **324**A, respectively, which hold the mating contact **310**. As shown in FIGS. **25** and **26**, the mating housing **320**A is further formed with two shell holding portions **326**A and two end part accommodation portions **332**A. Each of the shell holding portions **326**A projects outward in the lateral direction. As described later, the shell holding portions **326**A hold parts of the mating shell **350**A, respectively. Each of the end part accommodation portions **332**A is recessed inward in the lateral direction. Although each of the end part accommodation portions **332**A reaches both an upper surface, or a positive Z-side surface, and a lower surface, or a negative Z-side surface, of the mating housing **320**A, the present invention is not limited thereto. Each of the end part accommodation portions **332**A may not reach both the upper surface and the lower surface. However, considering miniaturization of the whole connector assembly **10**A, it is easier to manufacture the mating housing **320**A having the end part accommodation portions **332**A each of which reaches both the upper surface, or the positive Z-side surface, and the lower surface, or the negative Z-side surface, of the mating housing **320**A similar to the present embodiment.

As shown in FIGS. **27** and **28**, the mating shell **350**A is provided with two press-fit portions **380**A and two mating lock portions **360**A. The press-fit portions **380**A correspond to the shell holding portions **326**A, respectively. The mating lock portions **360**A correspond to the end part accommodation portions **332**A, respectively. As understood from FIGS. **24** and **28**, when each of the press-fit portions **380**A is press-fitted into the corresponding shell holding portion **326**A, each of the mating lock portions **360**A is positioned outward of the corresponding end part accommodation portion **332**A in the lateral direction. Specifically, cavities are formed inside the mating lock portions **360**A by the end part accommodation portions **332**A, respectively, in the lateral direction. As understood from FIGS. **17**, **18**, **23** and **24**, under the connection state where the connector **100**A and the mating connector **300**A are connected with each other, ends of the lock portions **140**A are accommodated into the cavities of the end part accommodation portions **332**A, respectively. When the connector **100**A is to be released from the mating connector **300**A in this state, the lock portions **140**A abut against the mating lock portions **360**A, respectively. Specifically, each of the lock portions **140**A locks the corresponding mating lock portion **360**A so that the connector **100**A and the mating connector **300**A are maintained in the connection state of the connector **100**A and the mating connector **300**A. The second contact portions

134A are parts of the spring portions 132A, respectively. The shell contact portions 370A are positioned at ends of the mating lock portions 360A, respectively, in the lateral direction. The second contact portions 134A correspond to the shell contact portions 370A, respectively. In addition, as shown in FIG. 18, when each of the lock portions 140A locks the corresponding mating lock portion 360A, each of the second contact portions 134A is brought into contact with the corresponding shell contact portion 370A. Thus, the second member 120A and the mating shell 350A are electrically connected with each other. At that time, each of the second contact portions 134A is brought into contact with the corresponding shell contact portion 370A from an outside of the corresponding shell contact portion 370A in the lateral direction as understood from shapes and arrangements of the spring portions 132A. Specifically, as shown in FIGS. 18 and 19, in the present embodiment, only the first member 110 of the connector 100A is accommodated inside the mating connector 300A and the second member 120A is not accommodated thereinside. Accordingly, the first member 110 and the second member 120A are never short-circuited with each other.

As understood from FIGS. 17 to 23, when the first member 110 of the connector 100A is inserted into the mating connector 300A along the front-rear direction so that the connector 100A and the mating connector 300A are connected with each other, the first contact portion 112 of the first member 110 is brought into contact with the mating contact 310. In the aforementioned connection process, the spring portions 132A are resiliently deformed. At that time, the lock portions 140A are moved outward in the lateral direction and then moved inward in the lateral direction. Accordingly, the connector assembly 10A is under a state shown in FIG. 18 and each of the second contact portions 134A is brought into contact with the corresponding shell contact portion 370A. At that time, each of the lock portions 140A locks the corresponding mating lock portion 360A so that the connector 100A and the mating connector 300A are maintained in the connection state of the connector 100A and the mating connector 300A. At that time, only the first member 110 is positioned at the inside of the mating connector 300A as described above. Accordingly, the first member 110 and the second member 120A are maintained in a state where the first member 110 and the second member 120A are electrically separated from each other. Thus, in the connector 100A of the present embodiment, the first member 110 and the second member 120A can be prevented from being short-circuited with each other without being provided with a housing. Accordingly, a height of the connector 100A can be lowered so that the connector assembly 10A can be reduced in height.

As shown in FIGS. 17 and 18, under the connection sate where the connector 100A and the mating connector 300A are connected with each other, when the spring portions 132A are resiliently deformed so as to open outward in the lateral direction by a jig (not shown), locks of the lock portions 140A against the mating lock portions 360A can be released. Accordingly, the connector 100A can be released from the mating connector 300A. Thus, the connector assembly 10A according to the present embodiment has a structure in which the connector 100A is repeatedly insertable into the mating connector 300A.

In the aforementioned embodiment, the shell contact portions 370A are formed as edges of ends of the mating lock portions 360A, respectively. However, the present invention is not limited thereto. For example, the shell contact portion 370A may be formed as a bent portion which is formed by folding or bending an end of the mating lock portion 360A. However, in a case where the mating lock portion 360A is formed by cutting and bending out a part of a side wall of the mating shell 350A similar to the present embodiment, it is necessary to cut and bend out a large part of the mating shell 350A in order to fold or bent the end of the mating lock portion 360A. In addition, the cutting and bending out of the large part of the mating shell 350A might cause degradation of a main function thereof. Accordingly, it is preferable that the shell contact portions 370A have shapes similar to the present embodiment.

Although each of the mating lock portions 360A of the present embodiment is formed by cutting and bending out the part of the side wall of the mating shell 350A as described above, the present invention is not limited thereto. For example, the mating lock portion 360A may be formed by expanding an end, or a negative X-side end, of the mating shell 350A to fold back the expanded portion of the end. In that case, the main function of the mating shell 350A is not degraded while the shell contact portion 370A can be formed by using a part other than the edge of the end of the mating lock portion 360A.

The present application is based on a Japanese patent application of JP2014-152134 filed before the Japan Patent Office on Jul. 25, 2014, the contents of which are incorporated herein by reference.

While there has been described what is believed to be the preferred embodiment of the invention, those skilled in the art will recognize that other and further modifications may be made thereto without departing from the spirit of the invention, and it is intended to claim all such embodiments that fall within the true scope of the invention.

What is claimed is:

1. A connector mateable with a mating connector along a front-rear direction and attachable to a cable which has a center conductor, an insulator, a shield, and an outer cover, the outer cover covering the shield, the insulator insulating the center conductor and the shield from each other, the mating connector comprising a mating contact and a mating shell, and the mating shell being provided with a mating lock portion and a shell contact portion, the connector comprising:

a first member; and

a second member which is formed separately from the first member;

wherein:

the first member is positioned frontward of the second member in the front-rear direction;

the first member has a first connection portion and a first contact portion;

the first connection portion is configured to be connected to the center conductor;

when the connector and the mating connector are connected with each other, the first contact portion is brought into contact with the mating contact;

the second member has a front portion and a rear portion which is positioned rearward of the front portion in the front-rear direction;

the rear portion is provided with a second connection portion which is configured to be connected to the shield;

the front portion is provided with a lock portion;

one of the rear portion and the front portion is provided with a second contact portion; and

under a state where the connector and the mating connector are connected with each other, the lock portion locks the mating lock portion while the second contact

portion is brought into contact with the shell contact portion, so that the first member and the second member are maintained in a state where the first member and the second member are electrically separated from each other.

2. The connector as recited in claim **1**, wherein the second member has only the front portion and the rear portion.

3. The connector as recited in claim **1**, wherein:

the second connection portion is to be crimped on the shield to be connected to the shield; and

a whole of the front portion is positioned frontward of the second connection portion in the front-rear direction.

4. The connector as recited in claim **1**, wherein the first member does not overlap the second member so that the first member is visible when the first member is seen along an up-down direction perpendicular to the front-rear direction under a state where the first member and the second member are attached to the cable.

5. The connector as recited in claim **1**, wherein:

the rear portion has an outer cover holding portion which is configured to hold the outer cover;

the outer cover holding portion is positioned at an uppermost part of the second member in an up-down direction perpendicular to the front-rear direction; and

the front portion is positioned below the outer cover holding portion in the up-down direction.

6. The connector as recited in claim **1**, wherein the lock portion is positioned frontward of the second contact portion in the front-rear direction.

7. The connector as recited in claim **1**, further comprising an insulator member, the insulator member being positioned between the first member and the second member in the front-rear direction while being positioned so as to surround the cable.

8. The connector as recited in claim **7**, wherein:

the insulator member has an inner periphery;

a first area is defined by the inner periphery in a plane perpendicular to the front-rear direction;

the first member has a rear end configured to be attached to the cable;

a second area is a total area of a cross-section of the rear end and a cross-section of the cable in a plane perpendicular to the front-rear direction; and

the first area is smaller than the second area.

9. The connector as recited in claim **7**, wherein the insulator member is formed by separating a part of an outer cover which covers the shield.

10. The connector as recited in claim **1**, wherein the first member is positioned apart from the second member in the front-rear direction.

11. The connector as recited in claim **10**, wherein the second contact portion is brought into contact with the shell contact portion from an inside of the mating connector under a connection state where the connector and the mating connector are connected with each other.

12. A connector assembly comprising the connector as recited in claim **10** and the mating connector, wherein:

the mating shell has a spring portion;

the mating lock portion and the shell contact portion are provided at the spring portion; and

under a state where the connector and the mating connector are connected with each other, the spring portion presses the shell contact portion against the second contact portion so that the second contact portion is sandwiched between the shell contact portion and the insulator.

13. The connector assembly as recited in claim **12**, wherein:

the mating connector comprises a mating housing which holds the mating contact;

the mating housing is provided with a first regulating portion;

the mating shell is provided with a second regulating portion; and

the second regulating portion abuts the first regulating portion to regulate a resilient deformation of the spring portion when the spring portion is resiliently deformed.

14. The connector assembly as recited in claim **12**, wherein:

the spring portion is provided with a tab which projects outward; and

a lock of the lock portion against the mating lock portion is released when the tab is operated by a jig so that the spring portion is resiliently deformed.

15. The connector as recited in claim **1**, wherein:

the front portion has a spring portion which is resiliently deformable;

the lock portion is supported by the spring portion; and

the spring portion is positioned outward of the mating shell under a connection state where the connector and the mating connector are connected with each other.

16. The connector as recited in claim **15**, wherein:

the spring portion is positioned outward of the rear portion in a lateral direction perpendicular to the front-rear direction; and

the spring portion extends frontward of the rear portion in the front-rear direction.

17. A connector assembly comprising the connector as recited in claim **15** and the mating connector, wherein:

the shell contact portion is positioned rearward of the mating lock portion and projects outward; and

the shell contact portion is brought into contact with the spring portion of the front portion from an inside of the spring portion.

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